he had exhumed bore traces of having been gnawed; and later on Adams made similar observations.

Notwithstanding, however, the most diligent research extending over a period of twenty years, no further evidences of the presence of carnivoræ were forthcoming. These were the first remains met with.

Equally interesting was the discovery which was made in Trench v. Among the remains which were exhumed Mr. Arthur Smith Woodward has determined the third metacarpal of man. It was found at a depth of 3 ft. 6 in. from the surface, and underlying a layer containing pottery. It is probably of great antiquity, having been extracted from one of the earliest layers in the cavern.

That these deposits are of great antiquity there can be no doubt. The state of mineralisation in which the bones were found was most complete; and when, in addition to this, the height of forty feet above the gorge bed at which the cavern is at present situated be considered, in conjunction with the extremely slow and gradual character of the processes of erosion which were engaged in cutting down the bed of the gorge to its present level—when these, and the other equally important points regarding the great changes in climate that have taken place between this and then be duly weighed, the author thinks that he would be justified in referring the Har Dalam deposits to a considerably remote epoch.

Such then in brief are a few of the evidences bearing on the prehistoric history of the Maltese Islands which these excavations have supplied us with—evidences which have added one more arch to the bridge with which the geologist and the archæologist in the Maltese Islands are endeavouring to span the gulf which at present divides their labours.

GEOGRAPHY IN CAUCASUS.

A RECENT volume of the Memoirs (Zapiski) of the Caucasian Branch of the Russian Geographical Society (vol. xv.) is of more than usual interest. It opens with a paper, by Mr. Konshin, on the old beds of the Amu-daria, accompanied by a map which shows the consecutive decrease of the area of the Caspian sea since the beginning of the Post-Pliocene epoch. It is known that the Russian geologist was first to point out that what had been previously described as old beds of the Amu are not beds at all, but elongated channels occupied once by the salt waters of the Caspian. The writers of antiquity were not wrong in representing the Caspian sea as a basin, elongated from west to east, and in ignoring the existence of Lake Aral as a lake separated from the Caspian. At the beginning of the Post-Pliocene epoch, and perhaps later on as well, the Caspian sent eastward two wide gulfs, one of which reached the longitude of Merv, and covered what is now a depression in the south of the Kara-kum elevated plain; while another gulf, stretching north-eastwards, included Lake Aral and what is now the delta of the Amu, as far as Khiva and Pitnyak. Thus, it was not the Amu which reached the Caspian, but the sea which reached the river by extending much further eastward than it does now. The Chink, which has so often been described as an old bed of the Amu, was the northern coast of the Kara-kum gulf; while the river-like beds of the Sary-kamysh depression were narrow channels through which the waters of Lake Aral occasionally found their way into the Caspian, long time after the two great lakes had been separated from each other. Mr. Konshin's little map very well illustrates the subsequent changes of the form of the Caspian. It may only be added that an exploration of the Ust-urt, and especially of the chain of lakes which crosses it from west to east—connecting, so to say, the Caspian with Lake Aral—is extremely desirable; it seems very probable that another channel of communication between the two great lakes will be discovered in that direction as well. A. V. Pastukhoff's communication about his ascension on the Elbrus and the Khalatsa peak, in July, 1890, is also full of interest, and is accompanied by excellent photographs and a map. On the top of this latter peak, which reaches 11,915 feet, the party was overtaken by a snowstorm, during which they were surrounded by a most beautiful display of electric fires; all their fur coats, their hair, their moustaches, as well as the poles of their tents and all metallic things, were enveloped in luminous discharges, which came to an end only after a discharge of thunder. The thunderstorm was terrible, especially one discharge of globular thunder, which rendered all the party senseless for a time.

Dr. Dinnik's descriptions of his journey in Western Ossetia, as well as in Pshavia and Khevsuria, are full of valuable observations, especially as regards glaciers and traces of an extensive previous glaciation of the main chain. And Mr. Filipoff's remarks relative to the present changes of level in the Caspian, show that the level of the sea is continually oscillating in its different parts, and never remains quite horizontal; it depends very much upon the different winds.

Mr. N. Alboff's reports of his botanical explorations in Abhasia and Lazistan are most valuable, the more so as his conclusions relative to the flora of West Caucasus, very different from those arrived at by MM. Krasnoff and Kuznetsoff, are based on most elaborate studies and extensive collections.

Another important paper is contributed to the same volume by K. N. Rossikoff, on the desiccation of lakes on the northern slope of Caucasus. These lakes belong to three different categories. Those on the coasts of both the Caspian sea and the sea of Azov have originated from old lagunæ, or in the deltas of the rivers. They attain but a small depth (3½ fathoms is the maximum depth observed), and many of them are brackish. The lakes of the Steppe-region occupy distinct depressions of the surface, and are fed by little temporary streams and underground water. And, finally, there is a small number of lakes at the footings of the Main Ridge and in the mountain region itself. Now, all the lakes relative to which there are reliable observations made during the years 1881 to 1891, are decidedly in a period of desiccation. Most of the lakes of the Steppe-region have either entirely disappeared, or are living the last years of their existence; they will exist no more in a few years. The lakes scattered at the foot of the mountains are also in decrease; their levels have sunk during the last eight years of the above period by an average of ninety inches. As to the lakes of the mountain region, their desiccation seems chiefly to depend upon the destruction of forests. These facts entirely confirm the widely-spread belief that the climate of Caucasus is becoming more and more dry during the last forty or fifty years.

The volume is concluded with an extensive paper by Dr. Pantyukhoff, full of most valuable anthropological measurements of representatives of the various nationalities and tribes of Caucasus, and accompanied by many engravings.

ISOPERIMETRICAL PROBLEMS.[1]

Dido, B.C. 800 or 900.
Horatius Cocles, B.C. 508.
Pappus, Book v. A.D. 390.
John Bernoulli, A.D. 1700.
Euler, A.D. 1744,
Maupertuis (Least Action), b. 1698, d. 1759.
Lagrange (Calculus of Variations), 1759.
Hamilton (Actional Equations of Dynamics), 1834.
Liouville, 1840 to 1860.

THE first isoperimetrical problem known in history was practically solved by Dido, a clever Phœnician princess, who left her Tyrian home and emigrated to North Africa, with all her property and a large retinue, because her brother Pygmalion murdered her rich uncle and husband Acerbas, and plotted to defraud her of the money which he left. On landing in a bay about the middle of the north coast of Africa she obtained a grant from Hiarbas, the native chief of the district, of as much land as she could enclose with an ox-hide. She cut the ox-hide into an exceedingly long strip, and succeeded in enclosing between it and the sea a very valuable territory[2] on which she built Carthage.

The next isoperimetrical problem on record was three or four hundred years later, when Horatius Cocles, after saving his country by defending the bridge until it was destroyed by the Romans behind him, saved his own life and got back into Rome by swimming the Tiber under the broken bridge, and was rewarded by his grateful countrymen with a grant of as much land as he could plough round in a day.

In Dido's problem the greatest value of land was to be enclosed by a line of given length. If the land is all of equal value the general solution of the problem shows that her line of ox-hide should be laid down in a circle. It shows also that if the sea is to be part of the boundary, starting, let us say, southward from any *given* point A of the coast, the inland bounding line must at its far end cut the coast line perpendicularly. Here, then, to complete our solution, we have a very curious and interesting, but not at all easy, geometrical question to answer :—What must be the radius of a circular arc ADC, of given length, and in what direction must it leave the point A, in order that it may cut a given curve ABC perpendicularly at some unknown point C? I do not believe Dido could have passed an examination on the subject, but no doubt she gave a very good practical solution, and better than she would have found if she had just mathematics enough to make her fancy the boundary ought to be a circle. No doubt she gave it different curvature in different parts to bring in as much as possible of the more valuable parts of the land offered to her, even though difference of curvature in different parts would cause the total area enclosed to be less than it would be with a circular boundary of the same length.

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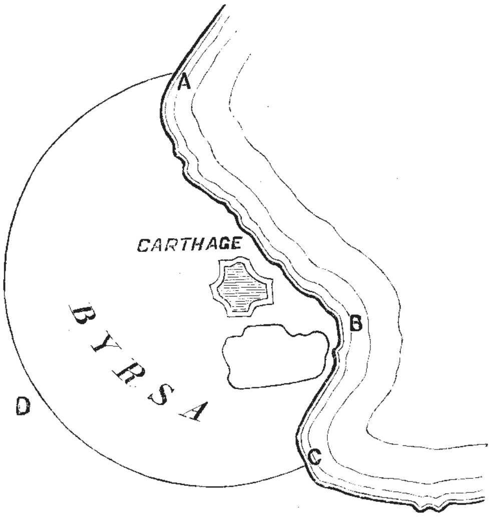
[1] A lecture delivered at the Royal Institution, May 12, 1893, by Lord Kelvin, Pres. R.S.

[2] Called Byrsa, from βύρσα, the hide of a bull. (Smith's "Dictionary of Greek and Roman Biography and Mythology," article "Dido.")



The Roman reward to Horatius Cocles brings in quite a new idea, now well known in the general subject of isoperimetrics: the greater or less speed attainable according to the nature of the country through which the line travelled over passes. If it had been equally easy to plough the furrow in all parts of the area offered for enclosure, and if the value of the land per acre was equal throughout, Cocles would certainly have ploughed as nearly in a circle as he could, and would only have deviated from a single circular path if he found that he had misjudged its proper curvature. Thus, he might find that he had begun on too large a circle, and, in order to get back to the starting-point and complete the enclosure before nightfall, he must deviate from it on the concave side ; or he would deviate from it on the other side if he found that he had begun on too small a circle, and that he had still time to spare for a wider sweep. But, in reality, he must also have considered the character of the ground he had to plough through, which cannot but have been very unequal in different parts, and he would naturally vary the curvature of his path to avoid places where his ploughing must be very slow, and to choose those where it would be most rapid.

He must also have had, as Dido had, to consider the different value of the land in different parts, and thus he had a very complex problem to practically solve. He had to be guided both by the value of the land to be enclosed and the speed at which he could plough according to the path chosen ; and he had a very brain-trying task to judge what line he must follow to get the largest value of land enclosed before night.

These two very ancient stories, whether severe critics will call them mythical or allow them to be historic, are nevertheless full of scientific interest. Each of them expresses a perfectly definite case of the great isoperimetrical problem to which the whole of dynamics is reduced by the modern mathematical methods of Euler, Lagrange, Hamilton and Liouville (Liouville's Journal, 1840-1850). In Dido's and Horatius Cocles' problems, we find perfect illustrations of all the fundamental principles and details of the generalised treatment of dynamics which we have learned from these great mathematicians of the eighteenth and nineteenth centuries.

Nine hundred years after the time of Horatius Cocles we find, in the fifth Book of the collected Mathematical and Physical Papers of Pappus of Alexandria, still another idea belonging to isoperimetrics—the economy of valuable material used for building a wall ; which, however, is virtually the same as the time per yard of furrow in Cocles' ploughing. In this new case the economist is not a clever princess, nor a patriot soldier, but a humble bee who is praised in the introduction to the book not only for his admirable obedience to the Authorities of his Republic, for the neat and tidy manner in which he collects honey, and for his prudent thoughtfulness in arranging for its storage and preservation for future use, but also for his knowledge of the geometrical truth that a "hexagon can enclose more honey than a square or a triangle with equal quantities of building material in the walls," and for his choosing on this account the hexagonal form for his cells. Pappus, concluding his introduction with the remark that bees only know as much of geometry as is practically useful to them, proceeds to apply what he calls his own superior human intelligence to investigation of useless knowledge, and gives results in his Book V. which consists of fifty-five theorems and fifty-seven propositions on the areas of various plane figures having equal circumferences. In this Book, written originally in Greek, we find (Theorem IX. Proposition X.) the expression "isoperimetrical figures," which is, so far as I know, the first use of the adjective "isoperimetrical" in geometry ; and we may, I believe, justly regard Pappus as the originator, for mathematics, of *isoperimetrical problems*, the designation technically given in the nineteenth century[1] to that large province of mathematical and engineering science in which different figures having equal circumferences, or different paths between two given points, or between some two points on two given curves, or on one given curve, are compared in connection with definite questions of greatest efficiency and smallest cost.

In the modern engineering of railways, an isoperimetrical problem of continual recurrence is the laying out of a line between two towns along which a railway may be made at the smallest prime cost. If this were to be done irrespectively of all other considerations, the requisite datum for its solution would be simply the cost per yard of making the railway in any part of the country between the two towns. Practically the solution would be found in the engineers' drawing-office by laying down two or three trial lines to begin with, and calculating the cost of each, and choosing the one of which the cost is least. In practice various other considerations than very slight differences in the cost of construction will decide the ultimate choice of the exact line to be taken ; but if the problem were put before a capable engineer to find very exactly the line of minimum total cost, with an absolutely definite statement of the cost per yard in every part of the country, he or his draughtsmen would know perfectly how to find the solution. Having found something near the true line by a few rough trials they would try small deviations from the rough approximation, and calculate differences of cost for different lines differing very little from one another. From their drawings and calculations they would judge by eye which way they must deviate from the best line already found to find one still better. At last they would find two lines for which their calculation shows no difference of cost. Either of these might be chosen ; or, according to judgment, a line midway between them, or somewhere between them, or even not between them but near to one of them, might be chosen, as the best approximation to the exact solution of the mathematical problem which they care to take the labour of trying for. But it is clear that if the price per yard of the line were accurately given (however determined or assumed) there would be an absolutely definite solution of the problem, and we can easily understand that the skill available in a good engineer's drawing-office would suffice to find the solution with any degree of accuracy that might be prescribed ; the minuter the accuracy to be attained the greater the labour, of course. You must not imagine that I suggest, as a thing of practical engineering, the attainment of minute accuracy in the solution of a problem thus arbitrarily proposed ; but it is interesting to know that there is no limit to the accuracy to which this ideal problem may be worked out by the methods which are actually used every day by engineers in their calculations and drawings.

The modern method of the "calculus of variations," brought into the perfect and beautiful analytical form in which we now have it by Lagrange, gives for this particular problem a theorem which would be very valuable to the draughtsman if he were required to produce an exceedingly accurate drawing of the required curve. The curvature of the curve at any point is convex towards the side on which the price per unit length of line is less, and is numerically equal to the rate per mile perpendicular to the line at which the Neperian logarithm of the price per unit length of the line varies. This statement would give the radius of curvature in fraction of a mile. If we wish to have it in yards we must take the rate per yard at which the Neperian logarithm of the price per unit length of the line varies. I commend the Neperian logarithm of price in pounds, shillings and pence to our Honorary Secretary, to whom no doubt it will present a perfectly clear idea; but less powerful men would prefer to reckon the price in pence, or in pounds and decimals of a pound. In every possible case of its subject the "calculus of variations" gives a theorem of curvature less simple in all other cases than in that very simple case of the railway line of minimum first cost, but always interpretable and intelligible according to the same principles.

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[1] Example, Woodhouse's "Isoperimetrical Problems," Cambridge, 1810.

Thus in Dido's problem we find by the calculus of variations that the curvature of the enclosing line varies in simple proportion to the value of the land at the places through which it passes; and the curvature at any one place is determined by the condition that the whole length of the ox-hide just completes the enclosure.

The problem of Horatius Cocles combines the railway problem with that of Dido. In it the curvature of the boundary is the sum of two parts; one, as in the railway, equal to the rate of variation perpendicular to the line, of the Neperian logarithm of the cost in time per yard of the furrow (instead of cost in money per yard of the railway); the other varying proportionally to the value of the land as in Dido's problem, but now divided by the cost per yard of the line, which is constant in Dido's case. The first of these parts, added to the ratio of the money-value per square yard of the land to the money-cost per lineal yard of the boundary (a wall suppose), is the curvature of the boundary when the problem is simply to make the most you can of a grant of as much land as you please to take provided you build a proper and sufficient stone wall round it at your own expense. This problem, unless wall-building is so costly that no part of the offered land will pay for the wall round it, has clearly a determinate finite solution if the offered land is an oasis surrounded by valueless desert. It has also a determinate finite solution even though the land be nowhere valueless, if the wall is sufficiently more and more expensive at greater and greater distances from some place where there are quarries, or habitations for the builders.

The simplified case of this problem, in which all equal areas of the land are equally valuable, is identical with the old well-known Cambridge dynamical plane problem of finding the motion of a particle relatively to a line of reference revolving uniformly in a plane: to which belongs that considerable part of the "Lunar Theory" in which any possible motion of the moon is calculated on the supposition that the centre of gravity of the earth and moon moves uniformly in a circle round the sun, and that the motions of the earth and moon are exactly in this plane. The rule for curvature which I have given you expresses in words the essence of the calculation, and suggests a graphic method for finding solutions by which not uninteresting approximations[1] to the cusped and looped orbits of G. F. Hill[2] and Poincaré[3] can be obtained without disproportionately great labour.

In the dynamical problem, the angular velocity of the revolving line of reference is numerically equal to half the value of the land per square yard; and the relative velocity of the moving particle is numerically equal to the cost of the wall per lineal yard in the land question.

But now as to the proper theorem of curvature for each case; both Dido and Horatius Cocles no doubt felt it instinctively and were guided by it, though they could not put it into words, still less prove it by the "calculus of variations." It was useless knowledge to the bees, and, therefore, they did not know it; because they had only to do with straight lines. But as you are not bees I advise you all, even though you have no interest in acquiring as much property as you can enclose by a wall of given length, to try Dido's problem for yourselves, simplifying it, however, by doing away with the rugged coast line for part of your boundary, and completing the enclosure by the wall itself. Take forty inches of thin soft black thread with its ends knotted together and let it represent the wall; lay it down on a large sheet of white paper and try to enclose the greatest area with it you can. You will feel that you must stretch it in a circle to do this, and then, perhaps, you will like to read Pappus (Liber V. Theorema II. Propositio II.) to find mathematical demonstration that you have judged rightly for the case of all equal areas of the enclosed land equally valuable. Next try a case in which the land is of different value in different parts. Take a square foot of white paper and divide it into 144 square inches to represent square miles, your forty inches of endless thread representing a forty miles wall to enclose the area you are to acquire. Write on each square the value of that particular square mile of land, and place your endless thread upon the paper, stretched round a large number of smooth pins stuck through the paper into a drawing-board below it, so as to enclose as much value as you can, judging first roughly by eye and then correcting according to the sum of the values of complete squares and proportional values of parts of squares enclosed by it. In a very short time you will find with practical accuracy the proper shape of the wall to enclose the greatest value of the land that can be enclosed by forty miles of wall. When you have done this you will understand exactly the subject of the calculus of variations, and those of you who are mathematical students may be inclined to read Lagrange, Woodhouse, and other modern writers on the subject. The problem of Horatius Cocles, when not only the different values of the land in different places but also the different speed of the plough according to the nature of the ground through which the furrow is cut are taken into consideration, though more complex and difficult, is still quite practicable by the ordinary graphic method of trial and error. The analytical method of the calculus of variations, of which I have told you the result, gives simply the proper curvature for the furrow in any particular direction through any particular place. It gives this and it cannot give anything but this, for any plane isoperimetrical problem whatever, or for any isoperimetrical problem on a given curved surface of any kind.

Beautiful, simple, and clear as isoperimetrics is in geometry, its greatest interest, to my mind, is in its dynamical applications. The great theorem of least action, somewhat mystically and vaguely propounded by Maupertuis, was magnificently developed by Lagrange and Hamilton, and by them demonstrated to be not only true throughout the whole material world, but also a sufficient foundation for the whole of dynamical science.

It would require nearly another hour if I were to explain to you fully this grand generalisation for any number of bodies moving freely, such as the planets and satellites of the solar system, or any number of bodies connected by cords, links, or mutual pressures between hard surfaces, as in a spinning-wheel, or lathe and treadle, or a steam engine, or a crane, or a machine of any kind; but even if it were convenient to you to remain here an hour longer, I fear that two hours of pure mathematics and dynamics might be too fatiguing. I must, therefore, perforce limit myself to the two-dimensional, but otherwise wholly comprehensive, problems of Dido and Horatius Cocles. Going back to the simpler included case of the railway of minimum cost between two towns, the dynamical analogue is this:—For price per unit length of the line substitute the velocity of a point moving in a plane under the influence of a given conservative system of forces, that is to say, such a system that when material particles not mutually influencing one another are projected from one and the same point in different directions, but with equal velocities, the subsequent velocity of each is calculable from its position at any instant, and all have equal velocities in travelling through the same place whatever may be their directions. The theorem of curvature, of which I told you in connection with the railway engineering problem, is now simply the well-known elementary law of relation between curvature and centrifugal force of the motion of a particle.

The motion of a particle in a plane is, as Liouville has proved, a case to which every possible problem of dynamics involving just two freedoms to move can be reduced. But to bring you to see clearly its relation to isoperimetrics, I must tell you of another admirable theorem of Liouville's, reducing to a still simpler case the most general dynamics of two-freedoms motion. Though not all mathematical experts, I am sure you can all perfectly understand the simplicity of the problem of drawing the shortest line on any given convex surface, such as the surface of this block of wood (shaped to illustrate Newton's dynamical theory of the elliptic motion of a planet round the sun) which you see on the table before you. I solve the problem practically by stretching a thin cord between the two points, and pressing it a little this way or that way with my fingers till I see and feel that it lies along the shortest distance between them. And now, when I tell you that Liouville has reduced to this splendidly simple problem of drawing a shortest line (geodetic line it is called) on any given curved surface every conceivable problem of dynamics involving only two freedoms to move, I am sure you will understand sufficiently to admire the great beauty of this theorem.

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[1] Kelvin, "On Graphic Solution of Dynamical Problems." *Phil. Mag.* 1892 (2nd half-year).

[2] Hill, "Researches in the Lunar Theory," Part 3. "National Academy of Sciences," 1887.

[3] "Méthodes Nouvelles de la Mécanique Céleste," p. 109 (1892).

The doctrine of isoperimetrical problems in its relation to dynamics is very valuable in helping to theoretical investigation of an exceedingly important subject for astronomy and physics—the stability of motion, regarding which, however, I can only this evening venture to show you some experimental illustrations.

The lecture was concluded with experiments illustrating—

(1) Rigid bodies (teetotums, boys' tops, ovals, oblates, &c.) placed on a horizontal plane, and caused to spin round on a vertical axis, and found to be thus rendered stable or unstable according as the equilibrium without spinning is unstable or stable.

(2) The stability or instability of a simple pendulum whose point of support is caused to vibrate up and down in a vertical line, investigated mathematically by Lord Rayleigh.

(3) The crispations of a liquid supported on a vibrating plate, investigated experimentally by Faraday; and the instability of a liquid in a glass jar, vibrating up and down in a vertical line, demonstrated mathematically by Lord Rayleigh.

(4) The instability of water in a prolate hollow vessel, and its stability in an oblate hollow vessel, each caused to rotate rapidly round its axis of figure,[1] which were announced to Section A of the British Association at its Glasgow meeting in 1876 as results of an investigation not then published, and which has not been published up to the present time.

GEOLOGICAL SURVEY OF THE UNITED KINGDOM.[2]

II.

SCOTLAND.

Lewisian Gneiss.—The most ancient rocks in the British Islands, forming what is known as the Lewisian Gneiss, have now been mapped continuously throughout the whole of their extent on the mainland, from Cape Wrath to the Kyles of Skye. They have been found to occur there in two distinct conditions. Along the western borders of Sutherland and Ross they form an irregular platform on which all later formations rest. The detailed work of the survey has brought to light the fact that this platform had an exceedingly uneven surface before the very oldest of the sedimentary formations were laid down upon it. Mountains of gneiss from 2000 to 3000 feet high, with wide and deep intervening valleys, already existed before the period of the Torridon Sandstone, and were submerged beneath the waters in which that Sandstone was accumulated. But to the east of this primeval topography, owing to the gigantic dislocations which have now been traced for upwards of 100 miles from the northern shores of Sutherland into Skye, large slices of the deeply buried gneiss have been torn off and have been driven westward upon fractured and crushed rocks of much later date. There are thus areas of gneiss which have been moved and have undergone much consequent internal rearrangement, while to the west of these the old platform, still in great part covered with the younger formations, has been left unaffected and reveals the condition of the oldest rocks at the time when the earliest of these over-lying formations was deposited upon them.

The mapping of this region has shown the Lewisian Gneiss to consist of what were probably masses of various deep-seated igneous rocks, which, partly by segregation and intrusion, and partly by subsequent intense mechanical deformation, have in large measure acquired a gneissic structure. An order of sequence has been made out among the more marked types of erupted material, and it has been further ascertained that the structures superinduced by crushing have taken place at successive periods of great disturbance.

Some of the most important observations in the area of the ancient gneiss are those made in the Loch Maree district. Mr. Clough has found there a group of rocks quite unlike the usual types of the Lewisian series. They consist chiefly of fine mica-schist, quartz-schist, graphite-schist, and limestone, and may be altered sedimentary rocks. If such should prove to be their origin they will possess a special interest as being by far the most ancient vestiges of detrital deposits yet detected in this country. The relation of these rocks to the normal types of gneiss around them have not been very satisfactorily determined.

In the course of the examination of the old gneiss where it lies undisturbed below the unmoved Torridon Sandstone, the officers of the Survey have ascertained that it had undergone successive disruptions and much mechanical deformation before the deposition of that Sandstone, that in short it had already acquired all its present structure and had been irregularly and deeply laid bare by denudation. We are still unable to say how far the earliest foliated arrangement of the gneiss may be due to movements such as those of flow-structure within a plutonic magma, in which the component minerals have segregated out. But there can be no doubt that after any such early structure had been established other structures were superinduced upon the gneiss by subterranean movements. Evidence of these disruptions and of their effects has now been accumulated over the whole area of the mainland.

Torridonian.—The striking mass of chocolate-coloured sandstones, which enters so prominently into the scenery of the west of Sutherland and Ross-shire, has now been mapped throughout its extent on the mainland, with the exception of a small area in the west of the latter county which remains to be completed. Like the far more ancient gneiss on which these strata rest with so marked an unconformability, they are met with in two distinct conditions. To the westward, where they have escaped from the great dislocations already referred to, they lie in almost their original undisturbed positions, insomuch that one can hardly at first realise that their relative antiquity can be so great as it demonstrably is. They resemble portions of the Old Red Sandstone with which at first they were identified, and this resemblance extends even into the practical uses that may be made of them. Along many parts of the West of Sutherland and Ross-shire the thick bedded chocolate-coloured freestones would furnish an excellent building stone in practically unlimited quantities.

An important group of shales has been found to occupy a prominent place towards the base of the Torridon Sandstone in Western Ross-shire. This group has now been followed to the sea-coast, and has been found by Mr. Clough to attain a still larger development in the southern part of the island of Skye. They there contain thin bands of impure limestone, and one of their members of much interest, forming only a thin bed, consists largely of grains of magnetite and zircon. A diligent search for fossils has recently been made by Mr. A. Macconochie in this lower shaly group of the Torridon Sandstone, but hitherto with scarcely any success, certain doubtful track-like markings being the only indications of possible organic remains which have been met with.

In mapping the Applecross district, where the Torridon Sandstone rises into an imposing group of mountains, Mr. Horne has encountered some singular volcanic orifices on a sandstone plateau about 1000 feet above the sea. Two small "necks" which rise there through the Torridon rocks, are filled with blocks of the sandstone mingled with occasional bombs of basalt, the whole being set in a dark green and grey paste of similar materials. The fragments of sandstone have been subjected to considerable alteration, for they have a glazed aspect, while their quartz-grains have acquired a milky opalescent or blue tint. There is no indication of the age of these two volcanic vents, but they may with some probability be assigned to the widespread Tertiary series which has left such prominent memorials in the opposite island of Skye.

During the past year in the district between Loch Kishorn

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[1] NATURE, 1877, vol. xv. p. 297, "On the Precessional Motion of a Liquid."

[2] Annual Report of the Geological Survey for the year ending December, 31, 1892. By Sir Archibald Geikie, F.R.S., Director General. From the Report of the Science and Art Department for 1892. (Some of those portions of the Report which describe the scientific results of the Survey operations during the last few years are reprinted here). (Continued from page 497.)